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(54) Industrial robot

(57) A robot for purposes of production and/or assembly comprises an arm (8) carrying a holder (11) for a tool (12), operating device or the like and being movable in three dimensions in consequence of appropriate guides. The holder (11) itself can have various degrees of freedom through arrangement of hinges, rotational axes or the like and all holder movements for individual operating processes may be programmable. The holder (11) is connected indirectly or directly to the arm (8) through a double parallelogram linkage (10) integrated into one unit, wherein the parallelogram linkage rod pairs (18, 19, 20, 22, 23, 27) extend obliquely one to the other, and a pivot angle displacing mechanism (30 to 35) is associated with this linkage (10). As shown the effective work zone 37 does not change with change of attitude of the holder (11) and tool (12).

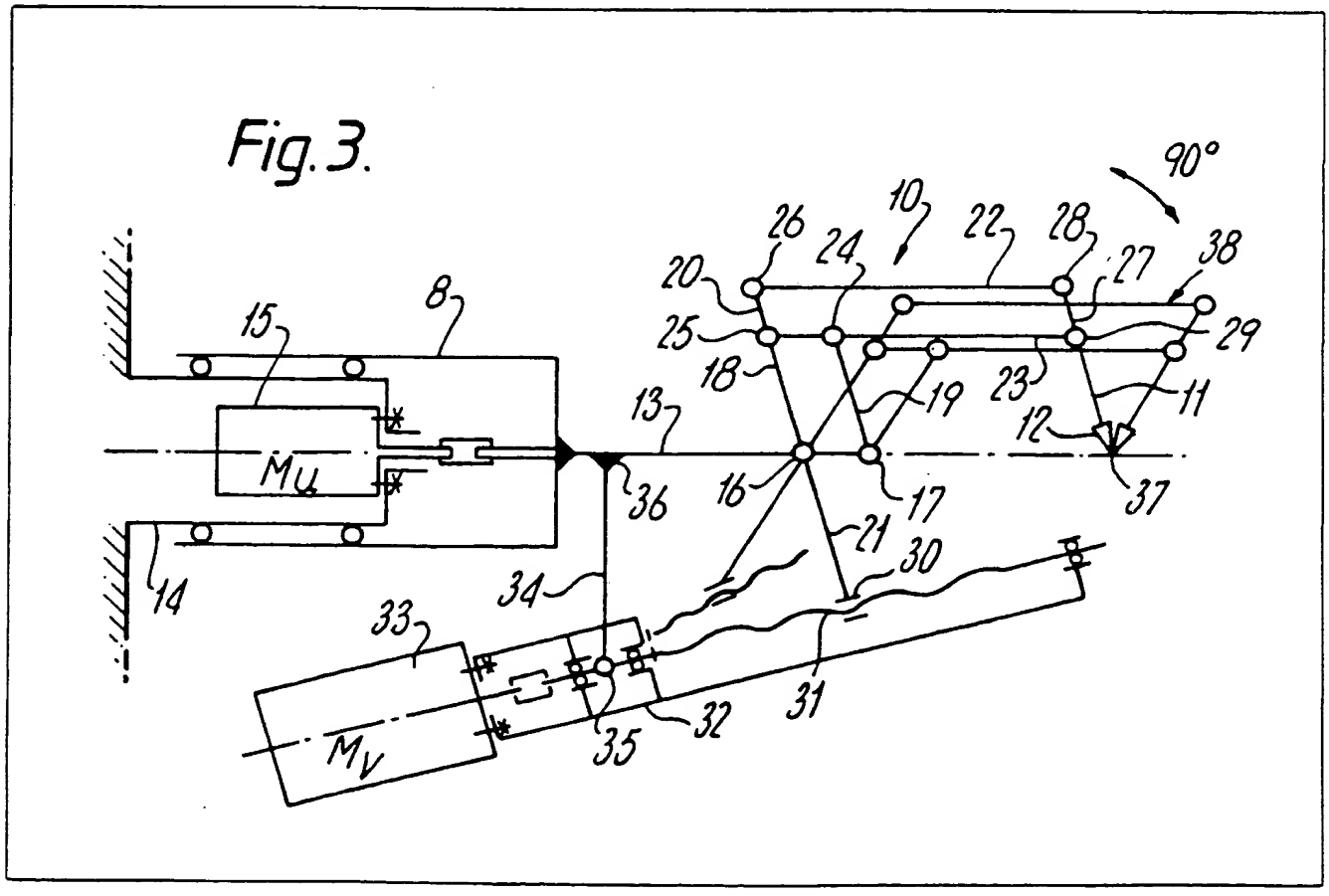

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Fig. 1.

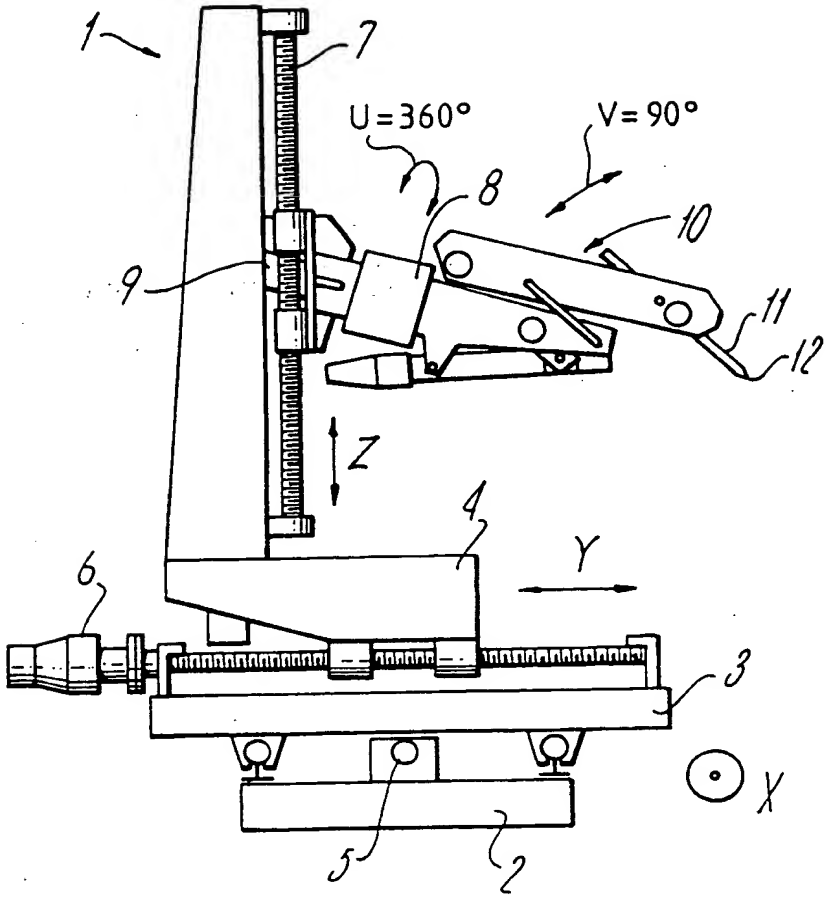


Fig.2.

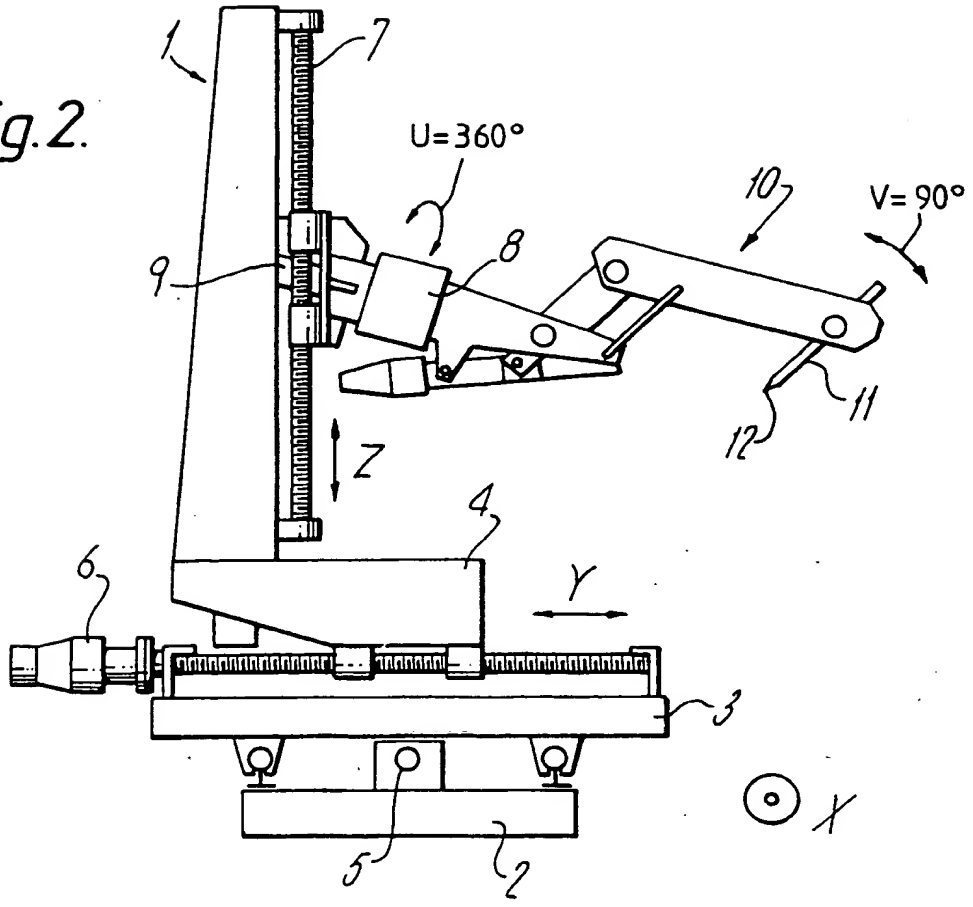
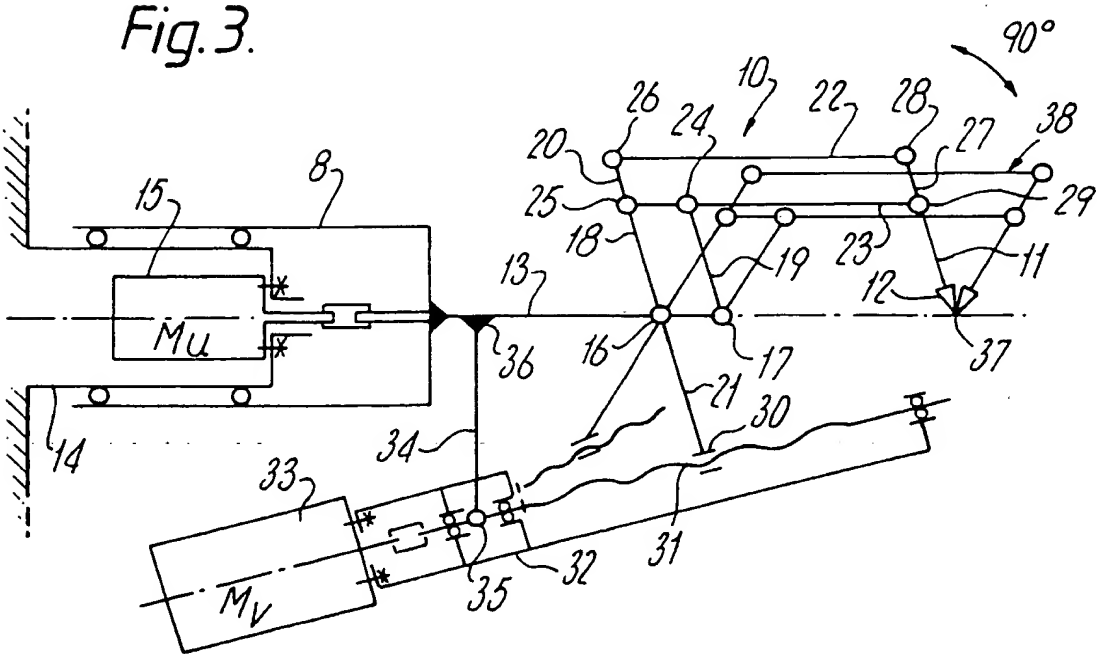

1
7
U=360°
10
V=90°
9
8
11
12
Z
4
6
Y
3
X
5
2

Fig.3.


90°
10
26
24
22
28
38
20
27
25
29
18
19
23
11
12
13
15
8
Mu
36
16
17
37
21
30
14
34
33
31
35
32
Mv

SPECIFICATION

Industrial robot

The present invention relates to a robot for purposes of production and/or assembly, and has particular reference to a robot having an arm which carries a holder for a tool, operating device or the like and which is movable in three dimensions, the holder itself possibly having various degrees of freedom through arrangement of hinges, rotational axes or the like and the holder movements for individual operating processes being programmable.

Robots for diverse purposes have become of increasing importance in recent times. They are used in situations when, in particular, constantly recurrent operation processes have to be performed and when it is important how accurately the work is performed or when quality specifications are set. Modern electronic technology has secured the advantage that rapid and reliable programming of even the most complicated operating processes can be achieved, in which case two methods are generally available. These methods, which in the language of the art are known as "off-line" or teach-in", permit programming or control of the robot to be performed remotely in terms of both space and time. In known robots, the "teach-in" method is utilised, in which the robot itself becomes the programmer. This represents a loss in operating time, as pre-programming cannot be performed independently of the robot. A further significant disadvantage in the known modes of construction of robots is that changes in the angle of a tool mounting result in changes to the spatial positions, which must then be reinstated, i.e. a program correction has to take place and this in turn is time-consuming.

It would thus be a desirable characteristic of a robot if the spatial position of the holder, or of a tool or an operating device held by the holder, does not get lost when the holder is turned or inclined. Moreover, it would be desirable to enable programming by the "off-line" method.

According to the present invention there is provided an industrial robot comprising an arm movable in three dimensions, a tool or component holder coupled to the arm by a double parallelogram linkage in which the parallelograms are so interconnected that one pair of parallel elements of one of the parallelograms extends at an angle relative to one pair of parallel elements of the other parallelogram, and displacing means for displacing the linkage to vary said angle.

In a preferred embodiment, the holder is connected directly or indirectly to the arm through a double parallelogram guide integrated into one unit, wherein the parallelogram guide rod pairs extend obliquely one to the other, and a pivot angle displacing mechanism is associated with the parallelogram guide. The advantage attributable to the arrangement of such a double-parallelogram guide can be appreciated by consideration of the case, by way of example only, of an assembly robot having a box-spanner type tool, by means of which a screw is to be introduced into parts to be connected together, inserted in the holder of the robot. After such an operating process has been preprogrammed, the introduction of the screw does not usually present any difficulties. If an axial correction of the tool holder is necessary for any reason, this can be readily undertaken, so the spatial position of the tool is not lost. Previously, a part of the program had to be changed for this purpose, which is no longer necessary here and thus a saving of time is effected. In addition, the "off-line" programming method can be utilized, i.e. the programmer can set up his program at a separate programming station and, after preparation of the program, transfer it to the computer. It is also of advantage that such measures represent only a small additional cost, which is of negligible significance compared with the costs that would arise if the same problems were to be overcome through electronic control.

In a preferred mode of construction, the parallelogram guide adjoining the arm has fixed articulation points on an axle of the arm, the axle being rotatably and drivably mounted in support means of the arm. In that case, it may be expedient for the pivot angle range of the holder, which is provided at the free end of the parallelogram guide extending away from the arm, to be at least 90°.

In order to keep the loadability at the holder as high as possible, the guide rod, near to the arm, of the parallelogram guide adjoining the arm may be prolonged beyond its pivot points in both directions and connected by one protruding end to a displacing spindle while the other end forms a guide rod of the parallelogram guide remote from the arm.

For a simple connection of the spindle with the appropriate prolonged end of the prolonged guide rod, it may be expedient to equip the spindle with a nut or other threaded element which is pivotably connected to the protruding rod end.

In order to create a closed and protected unit, which can automatically adapt to changing angles, the spindle may be mounted in a housing with a flange-mounted drive motor, the housing being pivotably connected to the axle of the arm.

Finally, it is advantageous, from the viewpoint of providing as many displacement permutations as possible, if the arm equipped with the double parallelogram guide engages a vertical guide to be displaceable in height, the vertical guide itself being arranged on a form of cross-slide.

An embodiment of the present invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic side elevation of a robot embodying the present invention, showing one end setting of a holder of the robot;

Figure 2 is a view similar to Fig. 1 but showing the other end setting of the holder; and

Figure 3 is a schematic representation, to an enlarged scale, of components of the robot showing the rage of movement of the holder and its associated guide linkage and displacing means.

Referring now to the drawings, there is shown in Figs. 1 and 2 a robot 1 for any desired purpose which comprises a base socket 2 on which a slide 3 is guided. This slide 3 carries a transverse slide 4 and the slides 3 and 4 together form a cross-slide. The two slides 3 and 4 are equipped with drives 5 and 6. The slide 4 carries a kind of column guide 7, which serves as a support for a carrier arm 8. With the described arrangement, the arm 8 is movable in three dimensions as represented in Figs. 1 and 2 by X, Y and Z.

The arm 8 is not only displaceable in height on the guide 7 but also rotatable, which can be achieved by a drive 9. Connected to the arm 8 is a double parallelogram guide linkage 10, which at its free end carries a holder 11 for a tool 12.

In Fig. 3, the double parallelogram guide linkage 10 is schematically shown in more detail. It can be seen that the arm 8 comprises an axle 13 and is rotatably mounted on a bearing spigot 14, the arm being drivable by a motor 15 for rotation through 360°. Two pivot points 16 and 17, to which guide rods 18 and 19 are connected, are disposed on the axle 13. The guide rod 18 has an upper prolongation 20 and an lower prolongation 21. Guide rods 22 and 23 extending obliquely to the guide rods 18 and 19 are pivotably connected thereto at pivot points 24 and 25 and the linkage is closed by a short guide rod 27 with pivot points 28 and 29. The guide rod 27 continues as the holder 11. The pivot range of the entire linkage amounts to 90°, as indicated by the curved double arrow.

The downwardly directed prolongation 21 of the guide rod 18 is pivotably connected at its free end to a nut 30, which is threadedly engaged on a displacing spindle 31. The spindle 31 is mounted in a housing 32, on which a drive motor 33 is mounted by a flange. For the pivotable mounting of the housing 32 in the plane of the axle 13, the housing 32 is partly encompassed by a fork 34 so that it can be pivoted about an axle 35 when this is required by the setting of the nut 30. The fork is firmly connected at 36 with the carrier arm axle 13.

The double-parallelogram guide linkage 10 operates in the following manner:

If it is assumed that the spatial tool position 37 has been programmed for an operating process and if for any desired reason it becomes necessary during the course of this process to change the attitude of the holder 11 or tool 12, a pulse is applied to the motor 33 and the spindle 31 displaces the double parallelogram guide linkage 10 from the setting indicated by the thick solid lines to the setting 38 indicated by the thin solid lines, the spindle together with the housing 32 and motor 33 being pivoted about the axis 35 as indicated by the reptesented part of the spindle associated with the setting 38. By virtue of the guidance of the holder 11 and tool 12 by the linkage 10, the effective work zone 37 of the tool does not change with the change in attitude of the holder and the tool.

CLAIMS

1. An industrial robot comprising an arm movable in three dimensions, a tool or component holder coupled to the arm by a double parallelogram linkage in which the parallelograms are so interconnected that one pair of parallel elements of one of the parallelograms extends at an angle relative to one pair of parallel elements of the other parallelogram, and displacing means for displacing the linkage to vary said angle.

2. A robot as claimed in claim 1, wherein the arm comprises an axle rotatably mounted in support means, the axle defining one of the elements of one of the parallelograms.

3. A robot as claimed in either claim 1 or claim 2, wherein the holder is arranged at an end of the linkage remote from the arm and the linkage is displaceable to pivot the holder through an angle of at least 90°.

4. A robot as claimed in any one of the preceding claims, wherein one of the elements of one of the parallelograms is provided by a member which is pivotably connected to the arm and which extends beyond that parallelogram in one direction to provide one of the elements of the other parallelogram and in a direction opposite to said one direction to provide a coupling lever coupling the linkage to the displacing means.

5. A robot as claimed in claim 4, the displacing means comprising a spindle and a threaded member which is movable along the spindle and is pivotably coupled to the coupling lever.

6. A robot as claimed in claim 5, the displacing means further comprising a housing rotatably mounting the spindle and drive means mounted on the housing and drivingly coupled to the spindle, the housing being pivotably supported by the arm.

7. A robot as claimed in any one of the preceding claims, comprising guide means

mounting the arm to be displaceable in height as one of said three dimensions, and a support bed mounting the guide means and thus the arm to be displaceable in the other two dimensions.

8. An industrial robot substantially as hereinbefore described with reference to the accompanying drawings.

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